Deployable Drag Device for Launch Vehicle Upper Stage Deorbit

Completed Technology Project (2013 - 2017)

Project Introduction

One of the biggest problems facing spaceflight today is the accumulation of orbital debris because it threatens the successful operation and lifespan of existing satellites. The predominant cause of orbital debris is the jettisoning of launch vehicle upper stages after their usefulness is over once a rocket reaches orbit altitude. While their orbit slowly decays, these obsolete upper stages then share an orbit with valuable satellites presenting a danger to those satellites by either hitting them or hitting other rocket bodies and breaking into smaller pieces which can be just as dangerous but become much harder to track. These collisions potentially add an exponentially growing number of debris in orbit. One way to reduce the number of rocket bodies in orbit is to have a drag device connected to the upper stage of the launch vehicle that deploys once it is jettisoned from the payload. The intent of this device is to increase atmospheric drag and thus accelerate deorbit. By reducing the time debris is in orbit we will reduce the amount of debris thereby reducing the threat to satellites. When designing this device, it is important to minimize the packaged mass and volume of the final design to minimize the impact on the launch vehicle payload capacity. This project requires background research to accumulate data on upper stage sizes and masses, final orbits, and the current time it takes them to deorbit. An orbital mechanics review would be required to determine the effectiveness of the drag device compared to size. This research will help to develop initial requirements to start the design phase of the device. The design depends greatly on the materials and the dynamics of the device. It requires a flexible membrane to allow packaging, and foldable booms to stiffen the membrane once it is deployed. These will most likely be made from composite materials. The dynamics will be determined through computer models and simulations, followed by the building of various prototypes to test the deployment and folding configurations. Testing the deployment will occur in three phases. The first is by offloading the gravity within the lab to facilitate quick design iterations based on test results. The second is testing the deployment in a reduced gravity aircraft for higher fidelity testing. Finally, it will be tested in space on either a cubesat or launch vehicle upper stage. The results of each round of testing will allow the design and models to be improved. The research required for this device applies to the technology area 12.3 Mechanical Systems because of the subsection 12.3.1 Deployables, Docking and Interfaces. This lower level element emphasizes the importance of being able to overcome the constraints of launch vehicle fairing size. The area of deployable space structures is still a fairly new research topic with a lot of room for development and study. This project will definitely help to increase the body of knowledge on the dynamics, design techniques, and testing techniques. The necessity for a reliable restraint/release mechanism will benefit development research, as well, as this is a very important aspect of any deployment system. The flexible sail material will require development and research into how flexible membranes stow and respond to the environment of space. Finally, it is possible that the goal of this project will

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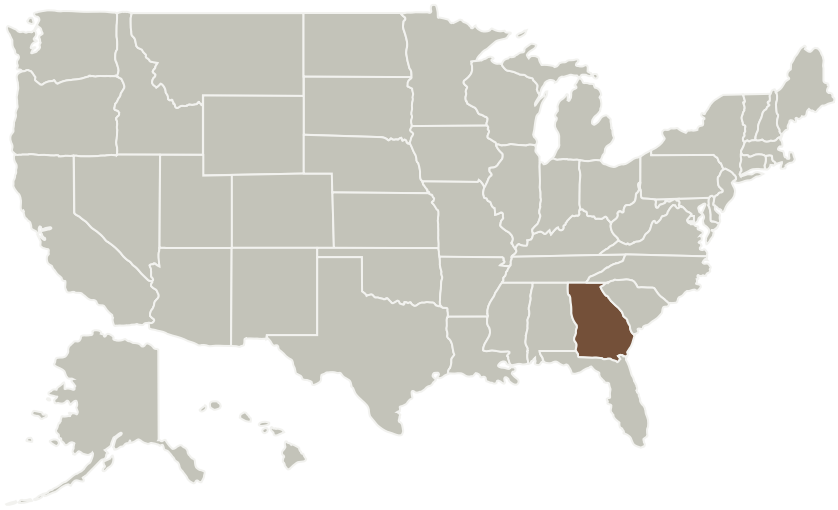
necessitate a fairly large deployable, which would increase research data for large lightweight stiff deployables.

Anticipated Benefits

This project will definitely help to increase the body of knowledge on the dynamics, design techniques, and testing techniques of deployable space structures.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Georgia Institute of Technology-Main Campus(GA Tech)	Lead Organization	Academia	Atlanta, Georgia

Primary U.S. Work Locations
Georgia

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Georgia Institute of Technology-Main Campus (GA Tech)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Glenn Lightsey

Co-Investigator:

Alexandra C Long

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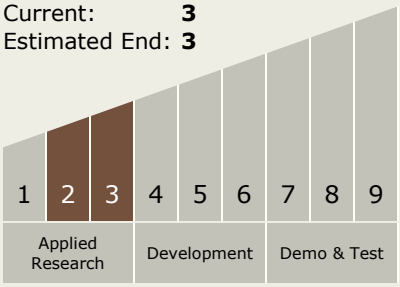
Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.3 Mechanical Systems
    - TX12.3.1 Deployables, Docking, and Interfaces

Target Destination

Earth